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Alternative Estimates of TFP Growth in China: Evidence from Application of the Dual Approach

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Abstract

This paper presents alternative sets of *dual* estimates of TFP growth rate in China based on alternative assumptions regarding the rate of return to capital in the "non-manufacturing" or "Other" sector (r_O). The purpose is to put the dual estimation of the Chinese TFP growth on a more robust foundation. Earlier, in view of paucity of direct data on r_O, Islam, Dai, and Sakamoto (2006) followed, what we call in the current paper, a *Hybrid route* to compute r_O in a residual manner by subtracting manufacturing value added obtained from China Industry Economy Statistical Yearbook (CIESY) from the economy-wide value added obtained from National Income Accounts (NIA). This approach however is not entirely satisfactory, because the computation then reverts to NIA, from which the dual approach strives to depart. In the Chinese case, the Hybrid route also, by construction, induces an upward trend in r_O, causing thereby an upward bias in the resulting dual estimates of TFP. This paper therefore offers two other sets of TFP estimates. The first of these assumes that the rate of return to capital in non-manufacturing sector is the same as to be found in the CIESY data for the Non State Enterprises (NSE) part of the manufacturing sector. This is therefore called the *CIESY route*, whose merit lies in the fact that it avoids using NIA data for computation of r_O. The problem however is that this route entails imposition of a sharply declining trend (that holds for the NSE part of the manufacturing sector) on a much wider swath of the Chinese economy, causing thereby a downward bias in the dual estimate of TFP growth. The paper therefore presents a third set of dual estimates, obtained following the *Neutral route* that is based on the assumption that r_O displays neither an upward nor a downward trend. The paper suggests estimates obtained from Hybrid and CIESY routes as the upper and lower bounds, respectively, of the TFP estimates and offers estimates from the Neutral route as the preferred ones. The qualitative features of the results presented in this paper prove to be the same as those presented in Islam, Dai, and Sakamoto (2006). Thus, TFP growth proves to be an important source of growth for China during the entire post reform period. Second, there has been some slowdown in TFP growth with the rate proving lower in more recent years than what it was in the initial years of reform.
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1. Introduction

Whether or not TFP growth is playing a significant role in China's recent economic growth is an important issue from several points of view. The first concerns sustainability of growth. As emphasized recently by Young (1995), Krugman (1994), and others, growth driven primarily by input accumulation may soon hit limits (because of diminishing returns) and hence prove not sustainable, as demonstrated by the experience of the former Soviet Union. By contrast, growth driven primarily by productivity growth may be more sustainable. Second, findings regarding relative contribution of input accumulation and productivity can be useful in formulating policies necessary to confront rising regional disparity that has now become a well recognized problem in China. A finding showing the importance of TFP growth may suggest that mere channeling of investment into lagging provinces may not ensure their faster growth unless it is associated with productivity growth.

In view of the above, it is not surprising that considerable amount of recent research on China has focused on the issue of her TFP growth. This research has generally revolved around the following two questions: (a) How significant has TFP's role been in recent Chinese growth? (b) Has TFP growth rate (TFPGR) slowed down in more recent years? Responding to these questions, researchers have presented a variety of answers. At one end, there are researchers who have provided very upbeat assessments of TFP's contribution to Chinese growth. They have also tended to suggest that the Chinese TFP is getting accelerated with further reforms. Among these researchers are for example Nogami and Li (1995), Hu and Khan (1997), Ezaki and Sun (1999), and Wang and Yao (2001). At the other end are researchers who have discounted the importance of TFP in Chinese growth. They have also tended to suggest that the Chinese TFP is decelerating. Prominent scholars holding the latter view include Young (2000) and Sachs and Woo (1997).

In producing these results, researchers generally have followed the *primal approach* to growth accounting that depends heavily on national income accounts (NIA) data. There are many reasons why their results vary despite this commonality of the methodological approach. Differences in coverage of sectors, sample period, specification of production function, choice of estimation method, etc. all play a role in this regard. However, an important source of the observed variation lies in the problems of the Chinese NIA data. As is widely known, despite attempts to rectify them, the Chinese NIA data continue to be beset with problems, as was illustrated again recently by the radical revision of the GDP figures in late 2005. The problems of the Chinese NIA data concern definition of output, choice of deflators, compatibility of data of different sub-periods, etc. Different ways in which researchers try to deal with these problems have been one important reason why results have varied across primal approach growth accounting exercises.

In view of these difficulties, Islam, Dai, and Sakamoto (2006) have advocated the use of the *dual approach* to growth accounting for China. The main usefulness of the approach lies in the fact that, unlike the primal approach, it does not have to rely exclusively on the NIA data. Instead it can make use of factor price information obtained from other, independent sources. The dual approach has a long pedigree. However, it has not been used as often as the primal approach. Recently, Hseih (2002) revived interest in this approach by making a good use of it in answering questions regarding sources of growth in Singapore and other Newly Industrialized Economies (NIEs) of East Asia. There have been other recent applications of the dual approach too.

However, application of the dual approach to China has its own problems. Factor price information that this approach requires is often not easy to get. First, there are difficulties with regard to appropriate wage rates, particularly when labor is distinguished by quality types. The problem is more acute with regard to the rate of return to capital. Until recently there was no organized capital market in China. Even now, the scope and coverage of the organized capital market in China remain very limited. China's banking sector is still dominated by government ownership, and so the bank rates (on deposit and lending) are to a considerable extent determined by administrative decisions rather than through market clearing. Finding the rate of return to capital in China is therefore a difficult task. This all more true for the rate of return that prevailed in past years.

The Chinese Industry Economy Statistical Yearbook (CIESY) provides some independent information on manufacturing enterprises' value added that can be used to compute the rate of return to capital in the manufacturing sector (r_M). One feature of r_M obtained from CIESY is its steady decrease from 26.34 percent in 1978 to 12.80 in 2002. This contrasts sharply with the NIA-based economy-wide rate of return to capital that remains steady between eleven to thirteen percent all through the period. Unfortunately, analogous independent information on value added in the non-manufacturing sector is not available. This makes computation of the rate of return to capital in the non-manufacturing sector or the "Other" sector, as it is called for easy reference, (r_O) difficult. Islam, Dai, and Sakamoto (2006), facing this difficulty, adopt, what we will call in this paper, a *Hybrid route*. Following this route, r_O is computed in a residual manner by subtracting CIESY data for manufacturing valued added from NIA data on economy-wide value added. This route is however not entirely satisfactory, because, first, it reverts the computation back to NIA data from which the dual approach strives to depart. Second, by construction, this route induces in r_O an increasing trend, which in turn imparts an upward bias in the computed TFP growth rates.

The current paper is an attempt to overcome this weakness. It views the estimates obtained from the Hybrid route as an *upper bound* on possible dual estimates of TFP growth rate in China. In order to do produce a more robust picture, this paper presents two other, alternative sets of dual estimates of TFPGR. One of these assumes that the rate of return to capital in the non-manufacturing or "Other" sector is the same as found for the Non State Sector part of the manufacturing sector in CIESY data. The paper calls this the *CIESY-route*. A major part of the "Other" sector is comprised of agriculture and service, which are also dominated by non-state enterprises and units (such as households). This commonality of ownership-type provides the rationale for the CIESY route, whose merit lies in the fact that it avoids NIA data all together and hence conforms to the spirit of the dual approach better. However, its demerit lies in the fact it imposes the sharply declining trend of the manufacturing sector's rate of return to capital on the larger non-manufacturing sector, and thus imparts a downward bias to the estimated TFPGR. The paper therefore views the estimates from the CIESY route as a *lower bound* on the dual estimates of the Chinese TFPGR.

The third set of dual TFP estimates presented in this paper is based on the neutral assumption that r_O witnessed neither a sharply increasing trend (as in the Hybrid route) nor a sharply declining trend (as in the CIESY route); instead it remained by and large unchanged. This route is therefore referred to as the Neutral route. The empirical basis of the assumption underpinning the Neutral route lies in the fact that the largest component of the "Other" sector is agriculture, which indeed did not see much capital accumulation during the reform years. As is known, most of the capital accumulation in recent China focused occurred in the industrial sector. Viewing estimates from the Hybrid and CIESY routes as the upper and lower bounds, this paper offers the estimates obtained from the Neutral route as the recommended dual estimates of TFP growth rate in China.

It is reassuring that the qualitative features of the results obtained from the Neutral-route prove to be the same as of those results presented in Islam, Dai, and Sakamoto (2006). We once again find that, first, TFP growth has been an important source of China's GDP growth during the entire reform period. Second, there indeed has been some slowdown in TFPGR in China, with the rate being considerably lower in recent year than what it was in the initial years of reform.

The discussion of the paper is organized as follows. Section 2 provides a brief outline of the dual approach to growth accounting. Section 3 presents the implementation of the dual approach for China and discusses the results. Section 4 concludes.

2. The Dual Approach to Growth Accounting[1]

The dual approach to growth accounting was proposed earlier by Jorgenson and Griliches (1967).[2] Having presented the expressions for TFP from the primal and dual approaches, they note that "these two definitions of total factor productivity are dual to each other and are equivalent. In general, any index of total factor productivity can be computed either from indexes of the quantity of total output and input or from the corresponding price indexes (p. 252)." There are many different ways in which the dual approach may be presented. A rather simple way is to proceed from the following national income accounting identity[3]:

$$Y = r\,K + w\,L, \tag{1}$$

where Y is the aggregate output (or aggregate income), r is the rate of return to capital, w is the real wage, L is labor, and K is capital. Upon differentiation with respect to time and dividing by Y, we get

$$\hat{Y} = s_K(\hat{r} + \hat{K}) + s_L(\hat{w} + \hat{L}) \tag{2}$$

where $s_k \equiv rK/Y$ and $s_L = wL/Y$ are factor income shares, and variables with "^" on top are corresponding growth rates, so that $\hat{Y} = (dY/dt)/Y$, $\hat{r} = (dr/dt)/r$, and $\hat{w} = (dw/dt)/w$. Rearranging equation (2), we get

[1] This section draws upon Section 3 of Islam, Dai, and Sakamoto (2006)
[2] For even earlier discussion of the basic duality for indexes of total factory productivity, they refer to Siegel (1952)
[3] This presentation follows Hsieh (2002)

(3) $$\hat{Y} - s_K \hat{K} - s_L \hat{L} = s_K \hat{r} + s_L \hat{w}.$$

The left hand side of equation (3) represents the usual, primal representation of the Solow residual, so that we can write

(4) $$SR_{primal} = \hat{Y} - s_K \hat{K} - s_L \hat{L}$$

However, equation (3) also shows that SR_{primal} is equal to the right hand side, which gives the dual representation of the Solow residual in terms of the share-weighted growth in factor prices, so that we can write

(5) $$SR_{dual} = s_K \hat{r} + s_L \hat{w}.$$

Note that this equality between SR_{primal} and SR_{dual} proceeds entirely from the national income identity and does not require any additional assumption regarding the form of the aggregate production function or equality between marginal product and factor return.

Just as the SR_{primal} can be interpreted as a measure of shift in the production frontier, provided the efficiency parameter is Hicks neutral and equality between marginal products and factor returns hold, SR_{dual} can also be interpreted under these assumptions as a measure of shift in the corresponding factor price frontier. Samuelson (1962) provides an elaborate discussion of the relationship between the production frontier and factor price frontier. Diamond (1965) and Phelps and Phelps (1966) in fact use factor price frontier in defining changes in total factor productivity.[4]

The equality shown by equation (3) also makes it clear that if one computes the SR_{dual} using r and w obtained from capital and wage income data provided by national income accounts, SR_{dual} should be exactly equal to SR_{primal}. Such an exercise would therefore be redundant.

[4] As Hsieh (2002, p. 503) explains, "In a simple model with two factors, say capital and labor, the outward shift of the factor price frontier is simply a share-weighted average of the growth rate of real wages and the rental rate of capital. According to the dual growth accounting formula, if real wage growth is entirely due to capital accumulation, the return to capital must fall by the same magnitude as the rate of real wage growth."

However, the usefulness of SR_{dual} lies in the fact that it can be computed based on factor price information from alternative sources, and such TFP estimates can then provide a useful check on the validity of SR_{primal} estimates and/or the validity of national income accounts data.

As is known, both the primal and the dual version of the Solow residual, as given by equations (4) and (5) above, are growth rates of continuous-time, Divisia-type indices. In order to compute Solow residual using discrete time data, Jorgenson and Griliches (1967) introduce a discrete time approximation to the Divisia index derived from Tornqvist index. Under this approximation, the TFP growth rate (TFPGR) between time *t-1* and *t*, as measured by SR_{dual} is given by:

(5')
$$TFPGR_{dt} = SR_{dual} = s_{L\tau} \cdot \hat{w}_t + s_{K\tau} \cdot \hat{r}_t$$

where $\hat{w}_t$ and $\hat{r}_t$ are growth rates of *w* and *r*, respectively, between *t*-1 and *t*, and

(6a)
$$s_{L\tau} = \frac{1}{2}\left[s_{L,t-1} + s_{L\,t}\right],$$

(6b)
$$s_{K\tau} = \frac{1}{2}\left[s_{K,t-1} + s_{K\,t}\right].$$

In other words, continuous time (exponential) growth rates are replaced by growth rates between discrete time periods *t*-1 and *t*, and the continuous time shares (*s*) are replaced by averages of the shares of *t*-1 and *t*.[5]

Just as is the case with the primal approach, the dual approach to growth accounting can also be extended to take into account improvements in the quality of inputs. As is known, this is usually done by allowing for different types of labor and capital.[6] The Divisia index framework facilitates the task. For example, assuming that there are *m* different types of labor, the overall wage growth rate, $\hat{w}$, can be derived as a share-weighted average of growth rates of wages of individual labor types, using the following formula:

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[5] It is also known that the Tornqvist indices are not only good approximation of the corresponding Divisia indices. They are also the exact indices if the underlying production function has the translog specification. To the extent that translog function can serve as the second order approximation to any other production function, the validity of the Tornqvist index is quite general. See Hulten (2000) for an excellent recent discussion of various issues regarding the theory and computation of TFP.

[6] See Jorgenson et al. (1987, p. 2) for further elaboration of this issue.

(7) $$\hat{w} = \sum_{j=1}^{m} s_{L_j} \hat{w}_j \ ,$$

where $\hat{w}_j$ is the growth rate of the wage of a worker of type *j*, and s_{L_j} is the share of wage payments to workers of type *j* in total wage payments. Similarly, if there are *n* different types of capital, the overall rate of change in the rate of return can be obtained as a weighted average of the rate of changes in the rate of return of these different types of capital, using the formula:

(8) $$\hat{r} = \sum_{i=1}^{n} s_{k_i} \hat{r}_i \ ,$$

where $\hat{r}_i$ is the rate of change of the rate of return of capital of type *i*, and s_{k_i} is the share of payments to capital type *i* in total payments to capital. This property of the Divisia index can be used to compute $\hat{w}_j$ and $\hat{r}_i$ based on sub-types into which labor of type *j* and capital of type *i* can be further disaggregated. In all cases, the Tornqvist approximation helps in estimating the Divisia growth rates using discrete (annual) data.

The necessity for accounting for input quality improvements while computing TFP can hardly be overemphasized. Note that TFP represents the *costless* part of the growth in output (in the primal approach) and returns to factors (in the dual approach).[7] We know that high educational attainments have been a key characteristic of East Asian growth. However, these societies had to incur substantial costs in order to achieve these educational attainments. Unless improvement in the quality of labor arising from higher educational levels is accounted for (instead of measuring the labor input only by the number of bodies or even hours), the TFPGR will be overestimated. From the dual point of view, wage growth achieved by having more people with higher education than before should not count as TFP growth. Only wage growth with unchanged labor quality (education) can be taken as reflective of TFP growth. Equation (7) allows us to capture that part of wage growth. If wages for workers of given levels of education do not increase, the value of $\hat{w}$ will be zero, even though the unweighted growth rate is positive. Similarly, the aggregate rate of return to capital may be higher just because of relatively more

[7] See Abramovitz (1962, p. 764), Griliches and Jorgenson (1967, pp. 250-51), and Hulten (2000) for further elaboration of this point.

productive capital goods being in place than before. However, the society has to incur costs in order to bring about the change (improvement) in the composition of its capital stock. Equation (8) allows us to capture the change in the rate of return to capital of a constant quality (composition). Thus, unless there are changes in the rate of return to capital of a given quality, the value of $\hat{r}$ computed using equation (8) will be zero, even though the unweighted average rate of return to capital may change.[8]

Although in terms of algebra the above framework is symmetric with respect to labor and capital, it differs in terms of the actual capability to capture their quality changes. This is because while there are independent physical measures of both quantity and quality of the labor input, such measures are generally absent for capital. For example, the quantity aspect of the labor input can be measured by the number of bodies or hours, and the quality aspect of the labor input can be measured by the number of schooling years. By contrast, given the heterogeneity of capital goods, there is no physical measure of the quantity of capital, either at the national, sectoral, or even plant level. Similarly, there is no physical measure of the quality that can apply to different types of capital goods. The Jorgenson-Griliches approach of taking the rate of return earned by a particular type of capital as a measure of its quality can in principle provide a way around the problem. However, data on such rates of return are often difficult to obtain. More importantly, this does not obviate the problem of absence of a physical measure of the quantity of capital. These problems are of general nature, and we encounter them in our growth accounting for China too.

There have been several prominent applications of the dual approach growth accounting in recent years. For example, Shapiro (1987) uses this approach to show that TFP movements are not caused by demand side shocks. As mentioned above, Hsieh (1999, 2002) provides a more important recent application, and serves as a reference point for the present study. Hsieh's work is a response to Young's (1992, 1995) earlier work showing that Singapore experienced negative TFP growth. Hsieh notes that constant capital share and spectacular capital stock growth suggested by Young's data (obtained from Singapore's national income accounts) would imply a significant fall in the rate of return to capital in Singapore.[9] Hence looking at the

[8] See Hsieh (2002, p. 506) for further discussion.

[9] "This evidence suggests that while the data on investment expenditures in the Korean national accounts are reasonable accurate, Singapore's national accounts significantly overstate the amount of investment spending." (p. 503) Note that

$$r = \frac{rK/Y}{K/Y} = \frac{s_K}{K/Y}.$$

dynamics of factor prices can provide an additional check on the validity of national accounts data on capital accumulation. With these goals in mind, Hsieh conducts a dual approach growth accounting exercise for the East Asian Tigers (namely Hong Kong, Korea, Singapore, and Taiwan) and produces TFP growth rates for these economies. He finds that while for Korea and Hong Kong the dual estimates of TFP growth are similar to the primal estimates, they exceed the primal estimates by more than 2 percentage points for Singapore. Hsieh shows that the reason for this large discrepancy lies in the fact that while Singapore national income accounts data imply a large decline in the rate of return to capital, independent information on these returns does not indicate any such a fall.[10] He observes that such a fall is not likely given the openness of the Singaporean economy to cross border capital mobility and given the already low level of the rate of return to capital at the beginning of the period.[11] This suggests that Singaporean national income accounts must have over reported capital accumulation.

Hsieh's use of the dual approach was thus prompted to a large extent by problems in the Singaporean national income accounts data.[12] There is therefore a parallel with the Chinese situation in this regard. As seen in the discussion of Section 2.2 above, Chinese national accounts data also suffer from considerable problems, though of different type and extent. Problems in national income accounts data are not uncommon, and it is not easy to completely eradicate them.[13] The use of the dual approach to growth accounting can therefore provide a useful alternative check on the results produced by the primal approach for China so far.

3. Implementing Dual Approach Growth Accounting for China

If s_K remains constant, *r* has to fall in exactly the same rate as rise of the capital-output ratio (*K/Y*). As Hsieh puts it, "Since the share of payments to capital in Korea and Singapore has remained roughly constant, the marginal product of capital implied by Korea's and Singapore's national accounts must have fallen by 3.4 percent and 2.8 percent a year respectively, the same rate as the increase in the capital-output ratio." (pp. 502-3)

[10] "This discrepancy is not explained by financial market controls, capital income taxes, risk premium changes, and public investment subsidies." (Hsieh 2002, p. 502)

[11] Actually, Hsieh's Figure-2 makes it clear that *r* did not have any further room to fall in Singapore. In 1962, *r*, as given by 'Average lending rate,' was already at the level of around 6-7 percent. In contrast, Hsieh's Figure-1 shows that *r* in Korea, as measured by curb loan rate was at the level of around 16-17 percent, and so there was considerable room to fall.

[12] As Hsieh (2002, p. 503) suggests, "As one solution to this problem, this paper presents price-based (dual) estimates of TFPG that do not rely on data from national accounts."

[13] As Hsieh (2002) notes, "Of course, this simply reinforces what anybody who has worked with national accounts data knows: that the task of computing reliable national income statistics is an impossibly difficult one and that, *even under the best of the circumstances, such statistics are riddled with large errors*." (p. 503)

A detailed review of the Chinese growth accounting literature is available in Islam, Dai, and Sakamoto (2006), which also provides a detailed discussion of the problems of Chinese National Income Accounts (NIA) data. This paper therefore proceeds directly to the implementation of the dual approach. In particular, we describe the three routes to arrive at the rate of return to capital in the non-manufacturing sector and the consequences they have on the overall results regarding TFP growth. The sample period considered in this paper runs from 1978 to 2002. We first discuss issues concerning wage growth before moving on to the issues related to the rate of return to capital.

3.1 Measuring Wage Growth[14]

The basic issues and the results regarding wage growth rate remain the same as presented in Islam, Dai, and Sakamoto (2006). In computing the $s_L \hat{w}$ part of SR_{dual}, we use equation (7) to allow for disaggregation with regard to both education level and residence (urban vs. rural). The disaggregation along these two lines turns out to be intertwined for China. Very few studies on China's TFP have attempted to incorporate changes in the quality of labor, with Young (2003) and Wang and Yao (2001) being exceptions. Both these studies have however conducted growth accounting following the primal approach and therefore needed to construct a *quantity index* of the labor input. In our case, we do not need the quantity index. All we need is a measure of wage growth that is net of the impact of improvement in quality of labor (through education). However, for that we need data on wages differentiated by quality types (e.g. by education categories) and also the distribution of the labor force among these quality types.

Distribution of Labor into Different Education Types

The distribution of educational attainment by levels of schooling in total Chinese population and labor force are available only in three recent censuses (1982, 1990, and 2000) and in several small sample-based "Surveys on Population Change" in recent years. In order to get similar distribution for all years of the sample period, we proceed from the 1990 distribution (obtained from the census) and extrapolate forward and backward using the perpetual inventory method introduced by Barro and Lee (1997, 2000) and implemented recently for China by Wang and Yao (2001). There are two reasons why we anchor our data construction on 1990 census. First is

[14] This part of the paper draws upon subsection 4.1 of Islam, Dai, and Sakamoto (2006)

that 1990 is the midpoint of our sample period of 1978-2002. Extrapolation (forward and backward) from the midpoint is likely to produce less bias than when it is done on the basis of census of either 1982 or 2000, which are close to the endpoints of the sample period. Second, the published census data for 1982 do not provide the kind of details that are necessary for our data construction, so that extrapolation on the basis of 1982 census is not a feasible option. The extrapolation however requires the knowledge of year specific enrolment (annual graduation flow data) and mortality rates. We obtain these rates from "Comprehensive Statistical Data and Materials on 50 Years of New China, 1949-98" and China Statistical Yearbooks. The formulas for the perpetual inventory computation are as follows.

$$(9) \quad SP_{0,t} = (1-d_t)SP_{0,t-1} + (PRI\_ENROLLED_{0,t} - PRI\_GRADUATED_{0,t+6})$$

$$(10) \quad SP_{1,t} = (1-d_t)SP_{1,t-1} + (PRI_t - JUNIOR_{t+3})$$

$$(11) \quad SP_{2.t} = (1-d_t)SP_{2,t-1} + (JUNIOR_t - SENIOR_{t+3} - SPECIAL_{t+3})$$

$$(12) \quad SP_{3,t} = (1-d_t)SP_{3,t-1} + (SENIOR_t - HIGHER_{t+3.5})$$

$$(13) \quad SP_{4,t} = (1-d_t)SP_{4,t-1} + SPECIAL_t$$

$$(14) \quad SP_{5,t} = (1-d_t)SP_{5,t-1} + HIGHER_t$$

where $SP_{j,t}$ is the number of persons in the population for whom j is the highest level of schooling attained, with j = 0 for incomplete primary, 1 for primary, 2 for junior secondary school, 3 for senior secondary school, 4 for specialized secondary school, and 5 for higher education.[15] If a person cannot complete the enrolled education level, we take that person as belonging to the schooling level he had before. The variable d_t is the annual mortality rate of the population.

[15] In order to conform to the definitions used in the censuses, the flow data for higher education include graduates from Adult Education Schools. This results in higher numbers of people belonging to E3 than would be case if these graduates were excluded and only graduated from regular schools were counted.

These equations are broadly similar to those of Wang and Yao (2001). However there are a few differences. First, we allow for a different category for “incomplete primary education.” In the classification of Wang and Yao, people with incomplete primary education are lumped with people with no schooling at all. Second, we take the number of years required to complete “specialized secondary school” to be three, instead of two, as assumed (incorrectly, in our view) by Wang and Yao.

Although the perpetual inventory exercise described above allows us to distinguish six different categories of education, corresponding data on wages are difficult to get, as noted earlier by Young (2003) and Wang and Yao (2001). In view of this difficulty, we collapse the education categories into three broad categories, namely “junior secondary school and below (Type *E1*),” “high secondary school (including specialized secondary school and vocational school) (Type *E2*),” and “higher education” (Type *E3*). Denote *P1*, *P2*, and *P3*, to be the number of persons in the *population* belonging to the three education type *E1*, *E2*, and *E3*, respectively.

The constructed values of *P1*, *P2*, and *P3* can be seen in Table 1. As a check, we compare the constructed values of *P1*, *P2*, and *P3* for 2000 with actual values obtained from the census of that year. We find the values to be very similar, suggesting that the constructed values are close to actual values of other years too.[16]

After obtaining the education distribution in *population*, we next compute the education distribution in *labor force*. The first step is to get the total labor force data. In view of absence of any other more reliable source, we depend in this regard on the China Statistical Yearbook (CSY). However, we make a few adjustments to the pre-1990 labor force data. Based on the results of the 2000 Population Census, the Chinese statistical authority has revised labor data for 1990-2000 significantly upwards, creating a huge jump (of 94.2 million) between the labor force figures of 1989 and 1990. Such a large increase in labor force in one year is unlikely. We therefore smooth out this jump by taking new 1990 labor data as the base and calculating backwards the labor force figures for 1978-1990 using the labor growth rates calculated from old data series for this period. This adjustment is made to all labor figures: total, urban, and rural.

The second step is to compute *L1*, *L2*, and *L3*, which are number of persons in the *labor force* belonging to education type *E1*, *E2*, and *E3*, respectively. To obtain *L3* from *P3*, we use the following formula:

[16] Unfortunately, as already mentioned, census data for 1982 do not provide necessary details for such a comparison.

(15) $L3 = P3\ (1\text{-}b)$,

where b is the proportion of $P3$ who are over 65 years of age and therefore do not belong to the labor force, at least officially. To obtain year specific values of b, we rely on the census data for 1990 and 2000, for which the value of b proves to be 2.40 and 1.67 percent respectively, reflecting the fact that in the intervening years the rate at which people reached education level $E3$ surpassed the rate at which the people of this education group were aging (crossing 65 years of age). The yearly rate of change of this percentage proves to be -0.036 for the period of 1990-2000. We use this rate to extrapolate and obtain year specific values of b and use them in equation (15). The values of $L3$ obtained through the above procedure are reported in column (10) of Table 1.[17]

The values of $L2$ are obtained using a similar equation (16):

(16) $L2 = P2\ (1\text{-}a)$.

Unlike b of equation (15), the value of a depends on two factors. The first is the proportion of $P2$ who are over 65 years of age and hence are out of the labor force. We may denote this part as a_1. The second is the proportion of $P2$ who enroll for higher education and hence are not in the labor force. We may denote this part as a_2. In actual data, the value of a is dominated by that of a_2. For example, for 1990 (according to census data), the values of a_1 and a_2 prove to be 0.9 and 3.8 percent respectively, yielding a value of a equal to 4.7. Value of a for 2000 (from census data) proves to be 9.52, indicating that much higher proportion of $P2$ got enrolled for higher education in 2000 than in 1990. This reflects the general spread of higher education in China over the years. These values of a for 1990 and 2000 suggest an annual rate of increase by 0.073 percentage points. We use this rate to extrapolate and get year specific values of a for the remaining years of the sample. These values of a are then used in equation (16) to obtain the year specific values of $L2$. Once the values of $L3$ and $L2$ are available, we can compute the value of $L1$, because $L1 = (L - L2 - L3)$.

The results of the above perpetual inventory calculation can be seen in Table 1. Column (2) shows the total population, while columns (3), (4), and (5) show number of people, $P1$, $P2$, and $P3$, belonging to the three education types, $E1$, $E2$, and $E3$, respectively. Column (6) shows

[17] It may be said that some of $P3$ who are over 65 continue to work and be in the labor force. However, conversely it is also true that some of $P3$ who are less than 65 do not participate in the labor market and hence remain out of the labor force. These two opposing influences may largely cancel each other.

the total educated population, *P*. Similarly, columns (7), (8), and (9) show number of laborers, *L1*, *L2*, and *L3* belonging to education type *E1*, *E2*, and *E3*, respectively, and column (10) shows the total educated labor force, *L*.

[Table 1 about here]

Wage Data for Urban Labor

In order to proceed further we need information on wages distinguished by these three education types. There are some urban wage data by education level (for 1993-2001) reported in post 1994 issues of China Labor Statistical Yearbook (CLSY). However, these wage data are based on small sample surveys, covering usually only four to five cities. Examination shows that these wage data are difficult to explain and far from being reliable. For example, according to these data, average wage rates for all education types are lower in 1995 than in 1994. This is highly unlikely. The probable reason for this anomaly is that while the 1994 survey included more of coastal cities, the 1995 survey included more of inland cities.

In view of these difficulties with CLSY data, we use CSY data to get education specific labor incomes. We first consider *urban* labor. Let w_{L1}, w_{L2}, and w_{L3} be the wage rates of urban labor of education type *E1*, *E2*, and *E3*, respectively. To the extent that *E3* represents higher education, we take w_{L3} to be equal to the average wage rate in science and technology research sector institutes and enterprises (in both state owned and private sector). Such institutes and enterprises usually have the highest share of labor with completed higher education. By analogous reasoning, we take w_{L2} to be equal to the average wage in the manufacturing sector, including both state owned and non-state owned enterprises.[18] Finally, we use the average wage of Collectively Owned Enterprises (COE) as w_{L1}. In China's Statistical system, COE is a type of small scale cooperatively owned enterprises, which (particularly the ones in the service

[18] Since the end of 1970s, labor growth in SOEs has been very slow. Usually only persons with completed senior secondary or special secondary education find employment in SOEs. On the other hand, SOEs do not attract and employ persons with completed higher education, except in some selected professional fields. Thus, employees of SOEs can be regarded as representing labor of education type *E2*. The same seems to be true with NSEs of the formal sector. We did the computation taking w_{L2} to be equal to average wage of the SOEs only. However, the results did not differ that much. The same was the case with w_{L3}. The results do not differ that much when w_{L3} is taken to be equal to the average wage of scientific and research enterprises in the state sector only instead of taking it to be equal to the average wage of such enterprises belonging to both state owned and non-state owned sectors.

sector) generally employ less educated urban labor and some of migrant rural labor. Information on urban wages obtained as above is provided in Table 2.

[Table 2 about here]

With the above information in hand, we can now compute the weighted average of urban wage growth rate. However, before going ahead with this computation, we need to take note of the situation with regard to the rural labor.

Special situation with Rural Labor

The education distribution of population and labor force shown in Table 1 apply to the nation as a whole, including both urban and rural areas. In principle, both urban and rural population and labor should fall into different education categories. However, data from Surveys on Population Change (China Labor Statistical Yearbook 2003) show that less than five percent of rural labor has completed senior secondary school or above. This would put 95 percent of the rural labor into education type *E1*. Furthermore, the quality of high school education in rural areas is much lower than that in urban areas, so that rural labor nominally belonging to type *E2* does actually belong to type *E1*, when quality of school education is taken into consideration. (As we shall soon see, the wage data for rural labor also validates this observation.) Also, though there are some official sample surveys on rural labor in China, none of these provide wage data distinguished by education categories. Thus even if we wanted to distinguish education type *E2* and *E3* in rural labor, we would not have corresponding data on wages. In view of this situation, we classify the entire rural labor (L_R) into education type *E1*.

Table 3 shows information on rural labor and wages. It gives total nominal rural wage, rural labor, nominal rural wage, and national CPI.[19] It would seem proper to deflate nominal rural wage using rural CPI. Unfortunately, the rural CPI is generally regarded as very problematic, so that the use of the national CPI is preferred for this purpose. These average real

[19] The rural nominal *wage* is computed from data on rural nominal *income*. It is true that not all of rural income may fall under the category of wages. However, capital intensity of the Chinese agriculture is still very low. Also, Chinese farmers have the land basically for free and do not have to pay for the use of land. These two circumstances together may justify taking income as a proxy for wages. Finally, even if one was skeptical about the above two arguments, there are no available data that would allow separate out capital income from wage in the rural income. This makes the assumption of equality between rural income and rural wage almost unavoidable. No wonder therefore that almost all related studies make this assumption.

rural wages (at 1978 prices), denoted by w_R, are given in column (7) of Table 3. The year-to-year growth rates of w_R, denoted as $\hat{w}_R$, are given in column (8). By comparing w_R with w_{L1}, the urban wage of labor of education type *E1* and shown in Table 2, we see that indeed the former is much lower than the latter, supporting our earlier observation about the inferior quality of rural education and hence the decision to classify all rural labor into education type *E1*.

[Table 3 about here]

Aggregation over Education and Residence Types

We first subtract L_R from *L1*, the total labor of education type *E1*, in order to get $L1_U$, the urban labor belonging to education type *E1*. Column (5) of Table 2 shows $L1_U$. The rest of the computation of the urban wage growth rate is shown in Table 4, and is carried out using the following equation:

(16) $$\hat{w}_U = s_{L1} \cdot \hat{w}_{L1} + s_{L2} \cdot \hat{w}_{L2} + s_{L3} \cdot \hat{w}_{L3},$$

where $\hat{w}_{L1}$, $\hat{w}_{L2}$, and $\hat{w}_{L3}$ are the growth rates of w_{L1}, w_{L2}, and w_{L3}, respectively, and s_{L1}, s_{L2}, and s_{L3} are share of wage payments made to *E1*, *E2*, and *E3* type labor in the total urban wage-payments, respectively. Columns (2), (3), and (4) show $\hat{w}_{L1}$, $\hat{w}_{L2}$, and $\hat{w}_{L3}$, while columns (5), (6), and (7) show the values of s_{L1}, s_{L2}, and s_{L3}, respectively.[20] The values of $\hat{w}_U$ are presented in column (8).

[Table 4 about here]

We can now compute the weighted average of the wage growth rate for the economy as a whole ($\hat{w}$), using the formula:

[20] The shares are computed following equations (6a) and (6b).

(17) $$\hat{w} = s_U \hat{w}_U + s_R \hat{w}_R .$$

These results are shown in Table 5. Columns (6) and (8) show the values of $\hat{w}_U$ and $\hat{w}_R$, respectively, from earlier Tables. Columns (5) and (7) show the values of s_U and s_R, respectively. These values show the secular rise in the former and decline in the latter, reflecting the process of urbanization that China has been undergoing. By 2002 more income is accruing to urban residents than to rural residents. The values of $\hat{w}$ can be seen in column (9).

Comparing the overall weighted wage growth rates of column (9) with the corresponding unweighted growth rates shown in column (4) of Table 5 (and similarly comparing the weighted urban wage growth rates of column (8) of Table 4 with corresponding unweighted growth rates shown in column (9) of that Table) we see that the weighted average growth rates are lower than the corresponding unweighted average growth rates, a result that is expected. However, the differences between the weighted and unweighted growth rates are small, indicating that much of wage growth during the period has been a result of TFP growth and not of rise in education level. This is an interesting finding, which however requires further probing based on more detailed breakdown of labor in terms of quality and more accurate information on labor quality specific wages.

[Table 5 about here]

3.2 Measuring Changes in the Rate of Return to Capital

In using the dual approach for developed countries or for NIEs such as Singapore (in case of Hsieh (2002)), researchers could use readily available rates of return observed in the capital market. In case of China, however, due to the non-existence or weakness of the capital market, such rates are not available readily and instead need to be computed on the basis of more primary information on value added and stock of capital. In the following, we first describe construction of capital stock data before moving to the issue of rate of return.

Estimating Capital Stock

Construction of capital stock data for China is beset with many problems too. Our capital construction exercise (presented in Table 6) begins with the gross investment series in current prices, shown in column (2). To bring these to constant 1978 prices, we use the GDP deflator, shown in column (3). (The deflator to be used for this purpose has been a question, and we will comment on this later.) The constant (1978) price investment figures are in column (4) of the Table. This investment series is then used to compute the capital stock using the perpetual inventory method using the following familiar equation:

(18) $$K_t = (1-\delta) K_{t-1} + I_t$$

where notations are obvious. The capital stock for the initial year, K_0, is computed using the formula:

(19) $$K_0 = I_0 / [g_0 + \delta_0]$$

where I_0 is the investment for the initial period, and δ_0 is the rate of depreciation applicable for the initial year, and g_0 is ideally the rate of growth of capital around the initial year. To the extent that value of capital stock is unknown, various proxies are used. For example, in computing initial capital stock for 1960, Hall and Jones (1999, p. 89, ff 5) takes g_0 to be "the average geometric growth rate from 1960 to 1970 of the investment series." In our case, we take 1957 as the initial year, and g_0 is taken to be 0.13, the average growth rate of investment during 1952-1957. As per Chinese official documents, the depreciation rate ranges between 0.02 and 0.04. We therefore take δ_0 to be equal to 0.03, the mid-point of this range. Note that since the period analyzed in this paper is 1978-2002, the assumptions made in computing the initial capital stock for 1957 will not have much influence in the capital stock data actually used.

[Table 6 about here]

It may be noted that the composition of the Chinese capital stock changed quite a bit over the last decades. In general, the share of "machinery and equipment," which depreciate faster, has increased relative to the share of "buildings and structures," which depreciate at a slower pace. This implies that the depreciation rate of the aggregate Chinese capital stock has increased over time. To reflect this process, we take the depreciation rate to be 0.03 for 1952-1978, 0.04 for

1979-1992, and 0.05 for 1993-2002. The rates assumed for the first two sub-periods are based on Chinese statistical authorities. The assumed rate for the more recent sub-period is based on recent papers such as Ezaki and Sun (1999) and Hu and Khan (1997b).

The estimated values of capital stock are influenced by the assumptions concerning deflators, initial capital stock, and depreciation rates. Table 6 offers a comparison of our estimated values of capital stock with those offered recently by other researchers. The comparison shows our capital stock figures to be larger than those of Hu and Khan (1997b) and Ezaki and Sun (1999). However, they prove smaller than those of Chow and Li (2002), who include land in their capital stock.

Rate of Return to Capital according to NIA Data

Before we compute the rate of return to capital using alternative sources information, we first check what this rate turns out to be when computed on the basis of the NIA data. This exercise is presented in Table 7. Columns (2) and (3) give 'Net Taxes' and 'Operation Surplus,' which together comprise the return to capital, net of depreciation, and is shown in column (4). Note that in Chinese national accounts, such data are available only at the provincial level. The national level figures in Table 7 are the result of aggregation of the provincial data.[21] These aggregate figures are then converted into 1978 prices using the GDP deflator (shown in Table 6) and are shown in column (5). These are then divided by the capital stock data of the corresponding years to obtain the rate of return to capital and are shown in column (6). This rate of return is denoted by r_{NIA} to indicate that it is obtained from NIA data. The year-to-year changes in r_{NIA} (as percentages of the base years' values) are shown in column (7). The compound average rates of change in r_{NIA} for different sub-periods of interest are shown in the bottom panel of the Table.

[Table 7 about here]

The main feature of the results is the relative constancy of r_{NIA}. Its value hovers around 11 to 12 percent during the entire 1978-2002 period. Such relative constancy contradicts the general expectation that capital deepening will pull the rate of return down as a result of

[21] This data series from 1978 are available in "The Gross Domestic Product of China 1952-1995" and "China Statistical Yearbook" (various years)

diminishing returns to capital. As data in Table 6 show, between 1978 and 2002, the aggregated capital stock has increased 7.8 fold, and per labor capital stock has increased by 4.8 fold. It is remarkable that, according to the NIA data, the rate of return to capital has remained relatively unchanged despite this enormous increase in capital.

Hsieh (2002) argues in the context of Singapore that such an outcome is untenable if capital-output ratio has increased and the share of capital in national income has remained unchanged.[22] However, unlike Singapore, data for China do not show significant rise in the capital-output ratio. Based on our capital stock estimates, the capital-output ratio (*K/Y*) for 1978 and 2002 are 3.39 and 3.06 respectively. Thus, instead of increasing, the capital-output ratio has declined somewhat.[23] Similarly, based on national accounts data, the value of capital share in income, β, has also remained almost constant. This would suggest that marginal product of capital, MP_K, has also remained constant. Thus unlike that of Singapore, the NIA data for China does not suggest any decline in the rate of return to capital. We now check whether evidence obtained from alternative sources indicates anything different.

Rate of Return to Capital in the Manufacturing Sector

For one such alternative source of information, we turn to industrial level data provided by "China Industry Economy Statistical Yearbook (CIESY)." Apart from being of a different source, an additional benefit of using these data is that they allow a two-level disaggregation. At the first level, we distinguish two sectors, namely "Manufacturing" and "Other." (The latter consists mainly of agriculture and service sectors.) At the second level, we distinguish capital by two ownership types, namely State Owned Enterprises (SOE) and Non State Owned Enterprises (NSE). Since 1978 the Chinese economy has been undergoing a radical transformation of ownership type. The share of state-ownership of capital assets has considerably fallen, while the share of various indigenous cooperative and individual ownerships has risen. In addition, there is now considerable intrusion of foreign ownership of various forms. It is often maintained that

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[22] This can be clearly seen from the following expression of capital share, $\beta = MP_K * \left(K/Y\right)$. Clearly, if (*K/Y*) goes up while β remains unchanged, MP_K has to fall.

[23] This finding regarding lack of capital deepening is not new. Earlier researchers have also been struck by this. For example, Hu and Khan (1997a, p. 3) make the following comment in this regard: "… although the capital stock grew by nearly 7 percent a year over 1979-94, the capital-output ratio has hardly budged. In other words, despite a huge expenditure on capital, production of goods and services per unit of capital remained about the same. This pronounced lack of capital deepening suggests a constrained role for capital."

capital under these various types of ownership differ in quality, manifested in very different rates of return they earn. A disaggregation in terms of ownership therefore may be helpful in netting out the impact of quality improvements in capital. Data limitations however restrict the second level disaggregation to the Manufacturing sector only.

Table 8 shows the computation of the average rate of change in the rate of return to capital in the Manufacturing sector. Column (2) of this table shows the rate of return to capital, denoted as r_M, in the sector as a whole. This rate is computed from CIESY with "profit plus taxes paid" as the numerator and the value of the fixed assets as the denominator for the entire Manufacturing sector. We see that r_M displays a clear declining trend, decreasing from a value of about 26 percent in 1978 to about 13 percent in 2002. Next we disaggregate the Manufacturing sector into its SOE and NSE parts and compute the return to capital for these sub-sectors separately. Column (3) shows the rate of return for the SOE part, denoted as r_{SOE}. We see that r_{SOE} displays a declining trend, falling from 25 percent in 1978 to 10 percent in 2002. The year-to-year changes of this rate of return (denoted as $\hat{r}_{SOE}$) are shown in column (5). The capital stock (value of fixed assets) of NSEs is calculated by subtracting the value of fixed assets of SOEs from the value of total fixed assets of the Manufacturing sector as a whole. Similarly, the profit-plus-tax of NSEs is computed by subtracting the profit-plus-tax of SOEs from the corresponding total for the Manufacturing sector as a whole. These are used as denominator and numerator, respectively, to obtain the rate of return to capital for the NSE part, denoted as r_{NSE}, and is shown in column (4). We see that r_{NSE} shows an even sharper declining trend, falling from a high of about 44 percent in 1978 to about 18 percent in 2002. The year-to-year changes in this rental rate (denoted as $\hat{r}_{NSE}$) can be seen in column (6).

[Table 8 about here]

With the disaggregated data available, we can calculate the rate of change in the rate of return to capital in the Manufacturing sector controlling for changes in the composition as a weighted average using the following formula:

(20) $$\hat{r}_{Mt} = s_{SOE,\tau} \cdot \hat{r}_{SOE,t} + s_{NSE,\tau} \cdot \hat{r}_{NSE,t}\,.$$

Columns (7) and (8) show the shares of SOE and NSE capital, denoted by $s_{SOE,\tau}$ and $s_{NSE,\tau}$, respectively, in total payments to capital in the Manufacturing sector. We can see that $s_{NSE,\tau}$ has steadily increased, from a mere 8 percent in 1978 to 31 percent in 2002. The $s_{SOE,\tau}$, correspondingly, has decreased from 92 percent in 1978 to 69 percent in 2002. The weighted year-to-year changes in the rate of return, $\hat{r}_M$, are shown in column (9). These may be compared with the unweighted year-to-year changes in the rate of return, $\hat{r}_M^{UN}$, shown in column (10). We see the weighted average rates to be (algebraically) lower than the unweighted average rates, as is expected. The difference proves substantial, indicating that composition (quality) changes in capita have counteracted the forces of diminishing returns to an appreciable extent.

Rate of Return to Capital in the Non-manufacturing Sector

The CIESY unfortunately does not provide comparable valued added data for the non-manufacturing or "Other" sector. Such data are not available from other sources either. There is a virtual absence of direct current and historical data on the rate of return to capital in the vast non-manufacturing part of the Chinese economy. This poses an important obstacle in the implementation of the dual approach. It is difficult to find any easy and satisfactory way around this obstacle. Facing this problem, this paper uses several indirect routes.

The CIESY-route

The first of these alternative routes is to stick to the CIESY data, and assume that the rate of return to capital in the "Other" sector is similar to that in the NSE part of the manufacturing sector. For easy reference, we call this the "CIESY route," and denote r_O obtained through this route as r_{OC}. The ground for this assumption is that the "Other" sector comprises mainly of agriculture and service sector (including very small scale manufacturing enterprises). Non-state ownership is preponderant in these sectors. Thus, the NSE part of manufacturing and the "Other" sectors have a similarity in terms of ownership, suggesting that the rate of return to capital in these two parts of the Chinese economy would be similar. Under this assumption, we therefore have $r_O = r_{OC} = r_{NSE}$. The values of r_{OC}, and changes in it over time are shown in columns (2) and (4) of Table 9. (These values are however same as those of r_{NSE} shown in columns (4) and (6) of Table 8.)

The direction in which this assumption will influence the results is clear. We already saw that r_{NSE} experienced a steep decline. By assuming r_O to be equal to r_{NSE}, we let this steep decline to extend to a much wider swath of the Chinese economy. As column (3) of Table 10 shows, the share of the "Other" sector in total capital income is more than 70 percent. As a result, the CIESY-route should cause the rate of return to capital for the entire economy to undergo a sharp decline. This can be seen from Table 10, according to the CIESY-route, the rate of return to capital for the entire economy (denoted by r_C), declines at a (compound) average rate of 3.58 percent per annum for the entire period of 1978-2002. This is a very different picture than what we get on the basis of NIA data. As we saw in Table 7, the rate of return to capital, according to NIA data, r_{NIA}, did decline by only 0.39 percent per annum on average over 1978-2002.[24] Clearly therefore, when computed following the CIESY-route, the TFP growth rate will prove to be low. The results obtained following the CIESY-route probably give a lower bound on the dual estimates of the Chinese TFPGR

The weakness of the CIESY-route lies in the fact that the NSE part of the manufacturing sector and the "Other" sector, while similar in terms of ownership pattern, are very dissimilar in other respects, such as capital composition, technology, organization, etc. For example, the NSE part of manufacturing sector employs industrial technology, is formally organized, and has higher capital-labor ratio. In contrast, Chinese agriculture, which is the largest component of the "Other" sector, still employs considerable amount of pre-industrial technology, has low capital-labor ratio, and does not have formal organization. The same may be said about the service and other small scale manufacturing (handicrafts and artisan production) enterprises which comprise another important part of the "Other" sector. More importantly, it may be argued that most of the "Other" sector did not witness the kind of capital deepening that the manufacturing sector did, and hence the rate of return to capital in the "Other" sector did not undergo the kind of

[24] What explains this discrepancy? The following observations by Hu and Khan (1997b) are pertinent in this regard: "The Chinese authorities regularly undertake fixed asset surveys for the state-owned sector, obtaining information on (1) gross stock of fixed assets valued at the original acquisition prices of the respective assets; and (2) the stock of fixed assets valued at current prices in the survey years, net of depreciation. In comparing the net stock value series, as reported by the official asset surveys, with the capital stock estimated using cumulated investment flows and the official depreciation table for the state-owned sector, large discrepancies emerge. One possible explanation is that the state owned enterprises (SOEs) and other state entities fail to use consistent price deflators for those asset surveys. Another possible reason is that official surveys suffer from serious reporting errors and omissions. In any event such official surveys are not conducted for urban collective and rural agricultural sectors, and thus do not cover the economy as a whole." (p. 110) This difficulty was also mentioned in the shorter version of Hu and Khan (1997a, p. 8): "Chinese asset surveys do not produce capital stock estimates consistent with the investment data in the national accounts. The difficulties of bridging this gap are considerable."

steep decline that we observe in the CIESY data for both the SOE and NSE parts of the manufacturing sector. These arguments would suggest that the assumption of equality between r_O and r_{NSE} may not be entirely satisfactory.

The Hybrid-route

A second possible route is what we call the "Hybrid route." We call it so because it relies on data from both CIESY and NIA. Along this route, we obtain the value of fixed assets for the "Other" sector indirectly by subtracting the value of fixed assets of the Manufacturing sector (obtained from CIESY) from the total capital stock of the economy, computed earlier through the perpetual inventory method and shown in Table 6. Similarly, we get the value of profit and taxes for the "Other" sector indirectly by subtracting the profit and tax of the Manufacturing sector (obtained from CIESY) from the total value of profit and tax in the economy, as obtained from NIA data. Taking latter as the numerator and the former as the denominator, we obtain r_{OH}, the hybrid variant of r_O. The results presented in Islam, Dai, and Sakamoto (2006) were obtained using the Hybrid-route.

The direction in which the Hybrid-route will influence the results is also clear. We saw that r_{NIA} does not show much decline. On the other hand r_M, according to CIESY data, show steep decline. Therefore when r_O is derived as a residual, it has to show, by construction, an upward movement. This is clearly seen from Table 9. Column (3) of this Table shows that r_{OH} increases from 6.32 percent in 1978 to 10.12 in 2002, implying a compound average rate of *increase* by 1.98 percent per annum. Therefore, the results obtained following the Hybrid-route probably provides an upper bound on dual estimates of the Chinese TFPGR.

The Neutral-route

In view of the weaknesses of the CIESY-route and the Hybrid-route, in this paper we offer another set of dual estimates of the Chinese TFPGR, following what we call the "Neutral route." We call it Neutral because it is underpinned by the neutral assumption that the rate of return to capital in the "Other" sector did witness neither a sharply declining trend (as implied by the CIESY-route) nor an upward trend (as implied by the Hybrid-route). Instead, it is assumed to have remained more or less unchanged. The main argument for this assumption is that the largest components of the "Other" sector, namely agriculture and services, did not experience the kind of capital deepening in China as has been true for her manufacturing sector. This is borne out both by data and by casual observation of the Chinese economy. According to the Neutral-route, the rate of return to capital in the "Other" sector (denoted by r_{ON}) is therefore assumed to be a constant, so that $\hat{r}_{ON}$, the rate of change in r_{ON}, is assumed to be zero.

Economy-wide Rate of Return to Capital

Having thus laid out the alternative assumptions regarding r_O and spelt out what influence they are likely to exert on the TFPGR, we can now proceed to complete the remaining computation. Needless to say, lack of data prevents us from disaggregation of the "Other" sector into SOE and NSE parts. However, given that most of the "Other" sector belongs to the NSE part of the economy, this may not matter much. We therefore proceed to aggregation over "Manufacturing" and "Other" sectors using r_M and three alternative measures of r_O, namely r_{OC}, r_{ON}, and r_{OH}.

The results from this computation are presented in Table 10. Columns (2) and (3) show s_M and s_O, the shares of the "Manufacturing" and "Other" sectors in total capital income. We use these shares in the following formula to compute the economy wide (weighted) rate of change in the rate of return to capital, and denote it by $\hat{r}$, so that

(21) $$\hat{r} = s_M \cdot \hat{r}_M + s_O \cdot \hat{r}_O .$$

Use of three variants of r_O yield three variants of $\hat{r}$, namely $\hat{r}_C$, $\hat{r}_H$, and $\hat{r}_N$, corresponding to r_{OC}, r_{OH}, and r_{ON}, and shown in columns (5), (6), and (7), respectively. From the values given in the bottom panel of the Table, we see that for the period 1978-2002 as a whole, $\hat{r}_C$ shows a decline of 3.58 percent per annum. On the other hand $\hat{r}_H$ shows an increase by 0.48 percent per annum. The neutral variant, $\hat{r}_H$, shows a decline, but of 0.97 percent per annum.

4.3. Dual Estimates of TFP Growth Rates

We now collect the results obtained in the above sections to compute the SR_{dual}, or the dual approach TFPGR using equation (5'). Before that, we first compute, for comparison's sake,

SR_{primal}, or the primal TFPGR. This computation is presented in the last few columns of Table 9. Thus columns (6), (7), and (8) of this Table give the year-to-year growth rate in GDP, labor, and capital. Column (9) shows s_L, the share of labor income in GDP, as per NIA data. These produce the primal TFPGR ($TFPGR_p$) shown in column (10). We see that the (compound) average value of $TFPGR_p$ for the entire 1978-2002 period equals 4.06 percent. For the initial 1978-1984 period of reform, this average proves to be 4.20 percent, whereas this average for the more recent 1992-2002 period proves to be 4.57 percent. So according the primal approach, the TFP growth rate is very high, and has also increased further in the more recent period. In other words, there has been some TFP acceleration.

The ingredients for computation of $TFPGR_d$ are in column (4) of Table 10, giving weighted growth rate of wage, $\hat{w}$, and in columns (5), (6), and (7), giving three alternative values of $\hat{r}$, namely $\hat{r}_C$, $\hat{r}_H$, and $\hat{r}_N$, respectively. The value of s_L is reproduced in column (8). The value of s_K, the share of capital in total income, is obtained by subtracting s_L from 1. The alternative values of $TFPGR_d$, namely $TFPGR_{dC}$ $TFPGR_{dH}$ and $TFPGR_{dN}$, obtained from combining $\hat{w}$ with these alternative values of $\hat{r}$, respectively, are presented in columns (9), (10), and (11) of Table 10. The lower panel of these columns presents the average values of $TFPGR_d$ over relevant periods of interest. We see that results vary depending on which particular value of $\hat{r}$ is chosen. As observed earlier, the lowest values of $TFPGR_d$ are obtained when $\hat{r}_C$ is used. On the other hand, the highest values of $TFPGR_d$ are obtained when $\hat{r}_H$ are used. As already argued, these values of $TFPGR_d$ can be taken as lower and upper bounds of actual TFPGR. Our preferred $TFPGR_d$ values are the ones based on $\hat{r}_N$, the rate of return on capital obtained following the Neutral-route. Going by $TFPGR_{dN}$ values, the (compound) average growth rate of TFP in the Chinese economy over the 1978-2002 period as a whole proves to be 2.26 percent. For the initial years of reform, i.e. for 1978-84 sub-period, this rate has been 4.59 percent, while for the more recent years of reform, i.e. for 1991-2002 sub-period, this rate has been 3.21 percent.

Comparing these results with those from the primal approach presented earlier, we observe first that in general the dual estimates of TFPGR prove to be lower than those obtained from the primal approach. Second, while the primal approach results show some acceleration, the dual approach suggests deceleration in TFP in recent years. In making these comparisons, however, it needs to be remembered that the $TFPGR_p$ values shown in column (10) of Table 9 are obtained without controlling for changes in quality (or composition) of the inputs. These are therefore likely to be higher than if were obtained upon accounting for changes in quality (or composition) of inputs. In that sense, these $TFPGR_p$ growth rates are not directly comparable with the $TFPGR_d$ values that have been computed taking into account quality (composition) changes in labor and capital, to the extent was possible. However, our results also show that accounting for quality improvement does not affect the results radically. This goes to indicate that the results of the comparison are likely to hold in broad terms even when quality improvements were taken into account in computation of the primal estimate of *TFPGR*.

Comparing with other recent papers, we see that the dual estimates of TFPGR prove to be higher than the conservative primal estimates of TFPGR presented by both Young (2003) and Woo (1998). However, the dual estimates prove to be lower than the upbeat estimates of TFPGR presented by such researchers as Hu and Khan (1997a, b) and Wang and Yao (2001).[25] The deceleration suggested by the computed $TFPGR_{dN}$ values supports the view that institutional changes, such as the switch from communes to the household responsibility system in agriculture, played a much more important role in boosting output in the initial years of reform. By contrast, input accumulation is playing a relatively more important role in Chinese growth in more recent years.

TFP deceleration suggested by the computed $TFPGR_{dN}$ values also conforms better with the rising Chinese Incremental Capital-Output Ratio (ICOR) that has drawn attention of many researchers. Computations by Lu (2007) based on NBSC data show that the Chinese ICOR has increased from 2.8 during 1991-1995 to 4.3 during 1996-2000 and further to 5.1 during 2001-2005. Analogous figures based on adjusted GDP statistics are 2.7, 3.8, and 4.3. Such an upward trend in ICOR does not accord well with those primal approach studies that claim acceleration

[25] One thing that needs to be noted is that the contrast between the upbeat TFP growth rates of Hu and Khan and those of Young, Woo, and Wang and Yao may not be that great as it appears. This is because Hu and Khan's analysis does not take into account quality improvements of labor. Hence their estimates of TFP are inclusive of the contribution of human capital growth. On the other hand, both Young and Wang and Yao account for quality improvements in labor, and hence their TFP growth rates do not include the contribution of quality improvements in labor. As we can from the results of Wang and Yao, presented above, the total of human capital growth and TFP growth rates prove to 5.01 for the post reform period. (Analogous total for the pre-reform period proves to be 4.73 percent per annum) This is higher figure than even of Hu and Khan! Similarly, Young finds that while output per worker increases in the post-reform period by 3.6 percent, output per effective worker increases by 2.6 percent, suggesting a growth rate of human capital of about 1 percent. Adding this to his TFP growth rate would raise it to 2.4 percent, much higher than the measly 1.4 percent!

in Chinese TFP. Thus even though the dual estimates provide evidence of a major role of TFPGR in Chinese growth under reform, they also point to a concern arising from the recent TFPGR slowdown, which also finds reflection in the rising Chinese ICOR in recent years.

4. Concluding Remarks

This paper strives to put the dual estimation of TFPGR for China on a more robust footing by providing alternative sets of dual estimates of TFPGR based on alternative assumptions regarding the rate of return to capital in the non-manufacturing or the "Other" sector (r_O). The necessity for such robustness check arises from the fact that while independent (of NIA) data are available for computation of the rate of return to capital in the manufacturing sector, no such data are available for the "Other" sector. In view of this difficulty, Islam, Dai, and Sakamoto (2006) earlier adopted the Hybrid-route that computed r_O in a residual manner by combining data from both NIA and non-NIA (CIESY) sources. This paper presents two additional routes, namely the CIESY-route and Neutral-route at estimating r_O and producing corresponding TFPGR estimates. The paper shows that TFPGR estimates obtained from the Hybrid-route and CIESY-route are likely to suffer from upward and downward biases, respectively. It therefore offers the estimates obtained from the Neutral-route as the recommended dual estimates of the Chinese TFPGR.

This robustness check leaves the qualitative features of the dual estimates of the Chinese TFPGR intact. Thus TFPGR proves to be an important source of Chinese growth under reform, though the estimated TFPGR now prove somewhat lower than presented earlier (using the Hybrid-route). Second, the recent slowdown in the Chinese TFPGR is confirmed. In this respect the dual estimates continue to be in a sharp contrast to the primal estimates that claim acceleration in the Chinese TFP, and accord better with the widely reported rising Chinese ICOR.

Despite the robustness check presented in this paper, there remain many weaknesses in the application of the dual approach, arising from limitations in the data on wages and rate of return to capital. Differentiation of labor in terms of quality and getting information on quality specific wages present a big challenge. So far as rate of return to capital is concerned, even the Neutral-route recommended in this paper may not prove entirely satisfying. More independent and objective information in this regard may be desirable.

An alternative source of information regarding the rate of return to capital in China is International Financial Statistics (IFS), which provide “deposit rate” and “lending rate.” The former refers to “interest rates on institutional and individual deposits of one-year maturity.” The latter refers to “rate on capital loans to state-owned industrial enterprises during 1980-1989 and to all enterprises thereafter.” This information is much more independent of NIA than the rates of return that we used in our computation of dual TFPGR in this paper. However, as most researchers agree, the sphere of application of the IFS rates is very limited, so that these rates cannot be taken as representing the rate of return to capital in the broader Chinese economy. With time, as capital market develops in coverage and depth in China, other more representative rates of return will emerge. These future developments will however not solve the problem of finding the rate of return to capital that held in the past. For that research of historical nature will have to be conducted.

Despite these weaknesses, the exercise presented in this paper, in addition to that presented in Islam, Dai, and Sakamoto (2006) vindicate the usefulness of the dual approach in addressing issues concerning Chinese TFP. The recent radical revision in the GDP figures once again revealed the continuing weaknesses in the Chinese NIA. As long as these problems remain serious, the dual approach can provide a useful alternative way of examining the TFP issues. Even when weaknesses in NIA cease to be serious, the dual approach can provide a useful check on the validity of the estimates obtained from the primary approach.

From this perspective, we hope that, in addition to efforts to improve NIA, more inquires into the past will be undertaken in order to uncover information about the historical trends in different economic variables of interest, including the rate of return to capital, particularly in the non-manufacturing and non-formal sectors of the Chinese economy. Outcome of such efforts will provide firmer basis for implementation of the dual approach growth accounting with respect to China.

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Table 1: Labor Stock by Education Level
(10,000 persons)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Total	Educated Population				Labor by education level			
Year	popu-lation	P1	P2	P3	Total P	L1	L2	L3	Total L
1978	95617	42177	4322	502	47001	41101	4235	483	45820
1979	96901	45542	4965	515	51021	41461	4857	496	46815
1980	98124	48213	5539	540	54291	42409	5411	521	48340
1981	99389	51207	6003	563	57772	43500	5853	544	49897
1982	100863	53783	6264	646	60693	44967	6096	625	51689
1983	102331	56095	6427	705	63227	46065	6243	683	52991
1984	103683	58482	6535	755	65771	47934	6334	732	55000
1985	105104	60637	6665	810	68112	49681	6445	786	56913
1986	106679	62697	6842	879	70418	51066	6600	854	58521
1987	108404	64645	7059	974	72678	52495	6791	948	60233
1988	110163	66568	7285	1073	74926	53970	6988	1045	62003
1989	112704	68311	7520	1173	77004	54805	7190	1144	63139
1990	114333	69895	7753	1275	78924	56116	7388	1245	64749
1991	115823	71268	7965	1391	80625	56569	7564	1359	65491
1992	117171	72519	8157	1494	82170	56976	7716	1460	66152
1993	118517	73541	8344	1585	83470	57398	7859	1551	66808
1994	119850	74409	8511	1684	84604	57826	7980	1649	67455
1995	121121	75175	8695	1817	85687	58171	8113	1781	68065
1996	122389	75856	8903	1966	86725	58758	8264	1928	68950
1997	123626	76641	9141	2125	87907	59298	8436	2086	69820
1998	124761	77542	9401	2277	89220	59777	8624	2236	70637
1999	125786	78440	9786	2436	90662	60083	8918	2394	71394
2000	126743	82078	10351	2608	95038	60155	9366	2565	72085
2001	127627	85789	10942	2788	99520	60458	9824	2743	73025
2002	128453	89644	11545	3022	104211	60486	10279	2975	73740

Notes: P1 = SP0 + SP1 + SP2; P2 = SP3 + SP4; P3 = SP5. SP5, SP4, SP3, SP2, SP1 and SP0 are the numbers of persons in the population for whom the highest level of schooling is higher education (university and college), special secondary, senior secondary, junior secondary, primary, and incompletely primary, respectively. L is the size of the total labor force; L1 is the number of persons in the labor force who received education lower than senior secondary school; L2 is the analogous number of persons who completed senior secondary school education; L3 is the analogous number of persons who completed higher education. $L2 = P2(1 - a)$; $L3 = P3(1 - b)$; $L1 = L - L2 - L3$. As explained in the text, a and b are respectively proportions of P2 and P3 who do not belong to the labor force. We calculate the values of a and b for each year by interpolation based on census data for 1990, 2000, and 1982.

Source: CASS (1986), SSB (1990), SSB and MLSS (1990), PCOSC and SSB (1993), PCOSC and NBS (2002), NBS (2003), NBS and MLSS (2003), and the authors’ calculations.

Table 2: Urban Labor and Wage by Education Level

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Nominal wage rate			Composition of Urban labor			Real wage rate			Total real
Year	w_{L1}	w_{L2} (yuan)	w_{L3}	$L1_u$ (10,000)	$L2_u$	$L3_u$	w_{L1}	w_{L2} (yuan)	w_{L3}	wage (100 MY)
1978	506	597	669	6308	4235	483	506	597	669	604.3
1979	542	654	717	6228	4857	496	532	642	704	677.9
1980	623	752	851	6255	5411	521	569	686	777	767.6
1981	642	757	850	6396	5853	544	572	674	757	801.5
1982	671	769	857	6506	6096	625	586	671	748	837.3
1983	698	789	990	6670	6243	683	598	675	847	878.1
1984	811	955	1072	7087	6334	732	676	796	894	1048.7
1985	967	1112	1272	7589	6445	786	737	848	970	1182.5
1986	1092	1275	1492	7924	6600	854	782	913	1068	1313.4
1987	1207	1418	1620	8205	6791	948	805	946	1081	1406.0
1988	1426	1710	1931	8469	6988	1045	801	961	1085	1463.0
1989	1557	1900	2118	8313	7190	1144	741	904	1008	1381.9
1990	1681	2073	2403	8408	7388	1245	776	957	1110	1497.9
1991	1866	2289	2573	8543	7564	1359	833	1022	1149	1641.1
1992	2109	2635	3115	8685	7716	1460	885	1106	1307	1812.9
1993	2592	3348	3904	8852	7859	1551	948	1225	1429	2023.9
1994	3245	4283	6162	9024	7980	1649	957	1263	1817	2170.7
1995	3931	5169	6846	9146	8113	1781	990	1302	1724	2268.2
1996	4302	5642	8048	9730	8264	1928	1000	1312	1871	2418.0
1997	4512	5933	9049	10259	8436	2086	1020	1342	2047	2605.7
1998	5331	7064	10241	10756	8624	2236	1215	1610	2335	3218.3
1999	5774	7794	11601	11101	8918	2394	1335	1802	2682	3731.2
2000	6262	8750	13620	11221	9366	2565	1442	2015	3137	4310.0
2001	6867	9774	16437	11373	9824	2743	1570	2235	3759	5013.3
2002	7667	11001	19113	11526	10279	2975	1768	2536	4406	5955.2

Notes: $L1 = L1_u + L_R$ (total rural labor). Therefore, $L1_u = L1 - L_R$; $L2_u = L2$; $L3_u = L3$. w_{L1} is the average wage of L_{1u}. The average wage of urban Collectively Owned Enterprises is used as proxy of w_{L1}. w_{L2} is the average wage of L2. The average wage of workers of urban manufacturing sector enterprises (both state owned and non-state owned) is used as proxy of w_{L2}. w_{L3} is the average wage of L3. The average wage of employees of urban science and research sector enterprises (both state owned and non-state owned) is used as proxy of wL3. MY refers to million yuan. Total real wage for year i = $L1_i{*}W_{L1i} + L2_i{*}W_{L2i} + L3_i{*}W_{L3i}$.

Source: SSB (1998), SSB and MLSS (1990), NBS (2003), NBS and MLSS (2003), and the authors' calculations.

Table 3: Rural Wage Growth Rate

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Year	Total rural nominal wage (100 MY)	Rural Labor (10,000)	Nominal Wage Rate (yuan)	CPI (1978=100)	Total rural real wage (100 MY)	Real wage Rate w_R (yuan)	Wage growth rate $\hat{w}_R$ (%)
1978	1055.4	34793.6	303.3	100.0	1055.4	303.3	—
1979	1266.1	35233.1	359.3	101.9	1242.5	352.6	16.26
1980	1522.3	36154.1	421.1	109.5	1389.7	384.4	9.00
1981	1785.3	37103.4	481.2	112.3	1590.0	428.5	11.49
1982	2165.6	38460.5	563.1	114.5	1890.9	491.6	14.73
1983	2500.9	39395.2	634.8	116.8	2140.9	543.4	10.53
1984	2854.7	40846.5	698.9	120.0	2379.5	582.5	7.20
1985	3210.9	42092.3	762.8	131.1	2448.7	581.7	-0.14
1986	3438.4	43142.7	797.0	139.7	2462.1	570.7	-1.90
1987	3775.6	44289.7	852.5	149.8	2519.7	568.9	-0.31
1988	4488.4	45501.5	986.4	178.0	2521.3	554.1	-2.60
1989	5002.4	46491.7	1076.0	210.1	2381.4	512.2	-7.56
1990	5774.5	47708.0	1210.4	216.6	2666.3	558.9	9.11
1991	5995.8	48026.0	1248.4	223.9	2677.4	557.5	-0.25
1992	6663.6	48291.0	1379.9	238.3	2796.7	579.1	3.88
1993	7865.5	48546.0	1620.2	273.3	2878.0	592.8	2.37
1994	10461.5	48802.0	2143.7	339.2	3084.5	632.1	6.61
1995	13560.2	49025.0	2766.0	397.2	3414.3	696.5	10.19
1996	16388.0	49028.0	3342.6	430.1	3810.1	777.1	11.58
1997	17594.1	49039.0	3587.8	442.2	3979.1	811.4	4.41
1998	17977.5	49021.0	3667.3	438.6	4098.6	836.1	3.04
1999	18133.2	48982.0	3702.0	432.5	4192.8	856.0	2.38
2000	18216.0	48934.0	3722.6	434.2	4195.2	857.3	0.15
2001	18827.8	49085.0	3835.8	437.3	4305.9	877.2	2.32
2002	19369.6	48960.0	3956.2	433.8	4465.6	912.1	3.97
1978-2002							4.69
1978-1984							11.49
1984-1991							-0.63
1991-2002							4.58

Notes: Total nominal rural wage = (Rural population) * (Per capita income of rural population). MY refers to million yuan. Data in columns (6) and (7) are calculated using CPI. Average growth rates for 1978–2002, 1978–1984, 1984–1991, and 1991–2002 in this table and all other tables of this paper are compound averages, calculated as using the formula: Growth rate = $(X_t / X_1)^{(1/(t-1))} - 1$, where, X_1 and X_t are the values of item for period's first year and last year, respectively, and (t−1) is the length of the period.

Source: SSB (1985, 1990) and NBS (2003) for rural population, per capita income of rural population, rural labor, and rural CPI. Results in other columns are from the authors' calculations.

Table 4: Urban Wage Growth Rate

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Growth rate by education			Share in total wage			Urban growth rate	
Year	$\hat{w}_{L1}$ (%)	$\hat{w}_{L2}$ (%)	$\hat{w}_{L3}$ (%)	S_{L1}	S_{L2}	S_{L3}	$\hat{w}_{U}$ (%)	$\hat{w}_{U}^{UN}$ (%)
1978	—	—	—	0.53	0.42	0.05	—	—
1979	5.12	7.51	5.18	0.49	0.46	0.05	6.17	6.80
1980	6.93	6.96	10.41	0.46	0.48	0.05	7.12	7.61
1981	0.54	-1.79	-2.55	0.46	0.49	0.05	-0.76	-0.54
1982	2.47	-0.41	-1.15	0.46	0.49	0.06	0.86	1.04
1983	1.98	0.59	13.25	0.45	0.48	0.07	1.99	2.03
1984	13.13	17.86	5.44	0.46	0.48	0.06	14.91	14.73
1985	9.09	6.53	8.56	0.47	0.46	0.06	7.85	7.68
1986	6.03	7.66	10.14	0.47	0.46	0.07	7.06	7.05
1987	3.01	3.65	1.19	0.47	0.46	0.07	3.17	3.25
1988	-0.55	1.51	0.33	0.46	0.46	0.08	0.46	0.53
1989	-7.47	-5.84	-7.05	0.45	0.47	0.08	-6.68	-6.37
1990	4.72	5.82	10.04	0.44	0.47	0.09	5.71	5.89
1991	7.36	6.79	3.55	0.43	0.47	0.10	6.73	6.90
1992	6.22	8.19	13.78	0.42	0.47	0.11	7.91	8.02
1993	7.15	10.77	9.27	0.41	0.48	0.11	9.09	9.18
1994	0.88	3.08	27.19	0.40	0.46	0.14	5.17	5.01
1995	3.45	3.06	-5.12	0.40	0.47	0.14	2.10	2.36
1996	1.05	0.79	8.55	0.40	0.45	0.15	2.00	1.89
1997	2.02	2.29	9.38	0.40	0.43	0.16	3.29	3.31
1998	19.10	20.02	14.09	0.41	0.43	0.16	18.68	18.74
1999	9.85	11.90	14.89	0.40	0.43	0.17	11.58	11.82
2000	8.02	11.82	16.94	0.38	0.44	0.19	11.27	11.82
2001	8.90	10.93	19.84	0.36	0.44	0.21	11.93	12.49
2002	12.55	13.46	17.22	0.34	0.44	0.22	13.94	14.76
1978-2002	5.35	6.21	8.17	0.43	0.46	0.11	6.05	6.35
1978-1984	4.95	4.91	4.94	0.47	0.47	0.06	4.93	5.15
1984-1991	3.03	3.64	3.66	0.46	0.47	0.08	3.36	3.45
1991-2002	7.08	8.61	13.00	0.40	0.45	0.15	8.68	8.91

Notes: $\hat{w}_{L1}$, $\hat{w}_{L2}$, *and* $\hat{w}_{L3}$ are wage growth rates of labor categories, $L1_u$, *L2,* and *L3*, respectively.
$\hat{w}_u$ is the weighted urban overall wage growth rate, and $\hat{w}_u^{UN}$ is an unweighted rate, which is calculated from the data of total urban labor and total real urban wage (column (11) of Table 2).
The average values of s_{L1}, s_{L2} and s_{L3} for different periods shown in the bottom panel of columns (5), (6), and (7) are arithmetic averages of respective yearly values, while the average values of $\hat{w}_{L1}$, $\hat{w}_{L2}$, , $\hat{w}_{L3}$, $\hat{w}_u$ and $\hat{w}_u^{UN}$ are compound averages, as explained in the Table 3 footnotes.

Source: Authors' calculations.

Table 5: Overall Wage Growth Rate

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Year	Total wage (100MY)	Wage rate (yuan)	$\hat{w}^{UN}$ (%)	S_U	$\hat{w}_U$ (%)	S_R	$\hat{w}_R$ (%)	$\hat{w}$ (%)
1978	1660	362	—	0.36	—	0.64	—	—
1979	1920	410	13.25	0.35	6.17	0.65	16.26	12.64
1980	2157	446	8.79	0.36	7.12	0.64	9.00	8.33
1981	2392	479	7.40	0.34	-0.76	0.66	11.49	7.26
1982	2728	528	10.12	0.31	0.86	0.69	14.73	10.28
1983	3019	570	7.94	0.29	1.99	0.71	10.53	7.98
1984	3428	623	9.41	0.31	14.91	0.69	7.20	9.50
1985	3631	638	2.36	0.33	7.85	0.67	-0.14	2.38
1986	3776	645	1.12	0.35	7.06	0.65	-1.90	1.12
1987	3926	652	1.02	0.36	3.17	0.64	-0.31	0.92
1988	3984	643	-1.40	0.37	0.46	0.63	-2.60	-1.49
1989	3763	596	-7.25	0.37	-6.68	0.63	-7.56	-7.24
1990	4164	643	7.90	0.36	5.71	0.64	9.11	7.87
1991	4319	659	2.53	0.38	6.73	0.62	-0.25	2.33
1992	4610	697	5.67	0.39	7.91	0.61	3.88	5.44
1993	4902	734	5.30	0.41	9.09	0.59	2.37	5.08
1994	5255	779	6.18	0.41	5.17	0.59	6.61	6.02
1995	5683	835	7.16	0.40	2.10	0.60	10.19	6.90
1996	6228	903	8.19	0.39	2.00	0.61	11.58	7.81
1997	6585	943	4.41	0.40	3.29	0.60	4.41	3.97
1998	7317	1036	9.83	0.44	18.68	0.56	3.04	9.58
1999	7924	1110	7.15	0.47	11.58	0.53	2.38	6.57
2000	8505	1180	6.30	0.51	11.27	0.49	0.15	5.59
2001	9319	1276	8.16	0.54	11.93	0.46	2.32	7.34
2002	10421	1413	10.74	0.57	13.94	0.43	3.97	9.50
1978-2002			5.84	0.39	6.05	0.61	4.69	5.22
1978-1984			9.47	0.33	4.93	0.67	11.49	9.32
1984-1991			0.81	0.35	3.36	0.65	-0.63	0.78
1991-2002			7.18	0.44	8.68	0.56	4.58	6.39

Notes: Total wage is the sum of total urban real wage (column (11) in Table 2) and total rural real wage (column (6) in Table 3). The data in column (9) show weighted overall wage growth rate, and the data in column (4) show unweighted rate. The values of $\hat{w}_U$ and $\hat{w}_R$ are from previous Tables. The average values of s_U and s_R for different periods shown in the bottom panel are arithmetic average of respective yearly values, and the average values of $\hat{w}^{UN}$ are compound averages, as explained in the Table 3 footnotes.

Source: Authors' calculations.

Table 6: Estimation of China's Capital Stock

(In hundred million yuan and in 1978 price, unless otherwise indicated)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Gross fixed investment (current prices)	GDP Deflator (1978 =100)	Gross fixed investment	Capital stock (Note 1)	Comparison of several Estimations		
					Hu and Khan (1997b) (Note 2)	Ezaki and Sun (1999) (Note 3)	Chow and Li (2002) (Note 4)
1978	1377.9	100.0	1377.9	12289.7	8239.0	—	14112.0
1979	1474.2	103.6	1423.6	13221.7	8850.0	—	15273.0
1980	1590.0	107.5	1479.5	14172.3	9489.0	8324.6	16438.0
1981	1581.0	109.9	1438.8	15044.2	9993.0	8948.3	17268.0
1982	1760.2	109.8	1603.6	16046.1	10699.0	9680.6	18297.0
1983	2005.0	110.9	1807.2	17211.5	11525.0	10606.2	19515.0
1984	2468.6	116.4	2120.9	18643.9	12629.0	11752.6	20928.0
1985	3386.0	128.2	2640.6	20538.7	13984.0	13252.6	22755.0
1986	3846.0	134.1	2869.0	22586.2	15321.0	15079.4	24822.0
1987	4322.0	140.9	3067.9	24750.6	16847.0	17154.8	27123.0
1988	5495.0	158.0	3477.8	27238.3	18502.0	19466.2	30085.0
1989	6095.0	172.0	3544.1	29692.9	19423.0	21507.1	33445.0
1990	6444.0	181.7	3546.9	32052.0	20445.0	23090.2	36565.0
1991	7517.0	193.9	3876.3	34646.3	21718.0	24725.8	39776.0
1992	9636.0	209.2	4606.8	37867.2	23311.0	26823.1	43589.0
1993	14998.0	239.6	6258.7	42232.5	25532.0	29700.0	48994.0
1994	19260.6	287.2	6707.1	46828.0	28297.0	33372.6	55006.0
1995	23877.0	325.0	7346.9	51833.5	—	37593.8	61856.0
1996	26867.2	344.3	7804.2	57046.1	—	—	69304.0
1997	28457.6	347.0	8202.2	62395.9	—	—	77218.0
1998	29545.9	338.6	8726.6	68002.8	—	—	85692.0
1999	30701.6	331.0	9274.9	73877.5	—	—	—
2000	32499.8	334.1	9726.1	79909.8	—	—	—
2001	37460.8	338.1	11079.7	86994.0	—	—	—
2002	42355.4	337.2	12559.4	95203.7	—	—	—

Note 1: The values shown in this column are from authors' own calculations. The gross fixed investment series is used to compute the capital stock using the perpetual inventory method, $K_t = (1\text{-}\delta)\ K_{t\text{-}1}+I_t$. The capital stock for the initial year (1957), K_0, is computed using the formula $K_0= I_0 / (g_0 + \delta_0)$, where I_0 is the investment for the initial period, and δ_0 is the rate of depreciation applicable for the initial year, and g_0 is ideally the rate of growth of capital around the initial year. In this study, g_0 is taken as 0.13, which is the average growth rate of investment during 1952-1957, and δ_0 is 0.03, which is the average value of rate of depreciation usually used by China government. After 1978, δ is taken as 0.04 for 1978-1992, and 0.05 for 1993-2002.

Note 2: Hu and Khan (1997b) take depreciation rate to be 0.036 for 1978-94. Investment deflator they used are not shown in their paper, but seem to be obviously higher than those used in Ezaki and Sun (1999) and Chow and Li (2002).

Note 3: Ezaki and Sun (1999) take depreciation rate to be 0.049 for 1980-1995. For comparison, we converted the Ezaki and Sun's values, which are in 1995 prices, into those of 1978 prices.

Note 4: Chow and Li (2002) take depreciation rate to be 0.04 for 1978-1998. Land is included in their estimated capital stock.

Source: SSB (1997, 1998), NBS (1999-2003), and the authors' calculations.

Table 7: Return to Capital according to National Income Accounts Data

(In hundred million yuan, unless otherwise indicated)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Year	Net taxes (current prices)	Operation surplus (current prices)	Return to capital (current prices)	Return to capital (1978 prices)	Rate of return to capital (%)	Year to year change (%)
1978	464.3	1008.4	1472.7	1472.7	11.98	—
1979	493.4	1081.6	1575.0	1520.9	11.50	-4.01
1980	547.9	1215.6	1763.5	1641.0	11.58	0.66
1981	578.9	1237.0	1815.8	1652.5	10.98	-5.13
1982	615.3	1312.8	1928.2	1756.6	10.95	-0.34
1983	687.6	1468.6	2156.1	1943.5	11.29	3.15
1984	844.0	1754.4	2598.4	2232.4	11.97	6.04
1985	1080.3	2249.9	3330.2	2597.0	12.64	5.60
1986	1276.1	2467.0	3743.1	2792.3	12.36	-2.23
1987	1492.9	2960.8	4453.7	3161.3	12.77	3.32
1988	1949.9	3664.2	5614.1	3553.1	13.04	2.13
1989	2247.0	4039.8	6286.8	3655.6	12.31	-5.62
1990	2421.8	4052.8	6474.7	3563.8	11.12	-9.69
1991	2868.4	4808.8	7677.2	3958.9	11.43	2.77
1992	3562.6	6303.6	9866.3	4716.8	12.46	9.01
1993	4792.5	8266.0	13058.5	5449.3	12.90	3.59
1994	6372.2	10907.1	17279.4	6017.2	12.85	-0.41
1995	7515.9	12841.0	20356.9	6263.8	12.08	-5.95
1996	8533.9	14410.3	22944.2	6664.7	11.68	-3.32
1997	9796.9	15207.6	25004.5	7206.9	11.55	-1.14
1998	10498.1	14875.6	25373.7	7494.3	11.02	-4.59
1999	11111.5	15600.3	26711.8	8069.6	10.92	-0.89
2000	12664.5	17053.1	29717.6	8893.5	11.13	1.89
2001	13697.1	18252.3	31949.3	9449.6	10.86	-2.40
2002	14715.3	20292.6	35007.9	10380.7	10.90	0.38
1978-2002						-0.39
1978-1984						-0.01
1984-1991						-0.67
1991-2002						-0.42

Note: "Net taxes" and "Operation surplus" are aggregated from provincial data provided in tables of National Income Account. "Return to capital" (net of depreciation) at current price = Net taxes (current price) + Operation surplus (current price). It can also be calculated as follows: "Return to capital" (net of depreciation) at current price = GDP (current price) - payments to wages (current price) – depreciation of fixed assets (current price). "Rate of return to capital" is calculated as "Return to capital" (in 1978 price) / "Capital stock" (in 1978 price).

Source: SSB (1996–1997, 1997), NBS (1999–2003), and the authors' calculations.

Table 8: Rate of Return to Capital in the Manufacturing Sector

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	By ownership type (in manufacturing sector)							Overall change rate (%) (Manufacturing sector)	
	Rate of return (%)			Year to year change (%)		Capital share			
Year	r_M	r_{SOE}	r_{NSE}	$\hat{r}_{SOE}$	$\hat{r}_{NSE}$	S_{SOE}	S_{NSE}	$\hat{r}_M$	$\hat{r}_M^{UN}$
1978	26.34	24.76	44.09	—	—	0.92	0.08	—	—
1979	26.13	24.93	38.48	0.70	-12.73	0.91	0.09	-0.44	-0.78
1980	25.66	24.32	38.05	-2.47	-1.09	0.90	0.10	-2.34	-1.81
1981	23.99	22.90	33.24	-5.84	-12.65	0.89	0.11	-6.53	-6.52
1982	23.17	22.22	30.69	-2.94	-7.69	0.89	0.11	-3.46	-3.40
1983	22.89	21.66	32.17	-2.53	4.84	0.88	0.12	-1.69	-1.21
1984	23.43	22.30	31.30	2.94	-2.71	0.87	0.13	2.25	2.37
1985	24.89	22.40	45.21	0.45	44.44	0.89	0.11	5.63	6.21
1986	21.02	19.89	27.51	-11.21	-39.15	0.85	0.15	-14.81	-15.54
1987	20.67	19.72	25.62	-0.84	-6.86	0.84	0.16	-1.78	-1.65
1988	21.51	20.18	27.84	2.33	8.65	0.83	0.17	3.39	4.04
1989	18.24	17.45	21.72	-13.53	-21.99	0.81	0.19	-15.05	-15.19
1990	13.52	12.95	15.93	-25.81	-26.65	0.81	0.19	-25.97	-25.87
1991	13.02	12.25	15.89	-5.35	-0.23	0.79	0.21	-4.32	-3.74
1992	14.03	12.38	20.08	1.06	26.31	0.79	0.21	6.40	7.75
1993	15.20	12.87	21.76	3.97	8.37	0.74	0.26	5.02	8.35
1994	14.76	12.45	19.91	-3.29	-8.47	0.69	0.31	-4.77	-2.89
1995	11.23	9.29	15.48	-25.38	-22.24	0.69	0.31	-24.40	-23.93
1996	9.89	7.87	13.96	-15.26	-9.83	0.67	0.33	-13.51	-11.87
1997	9.64	7.58	13.35	-3.72	-4.36	0.64	0.36	-3.94	-2.60
1998	8.52	7.04	12.71	-7.19	-4.79	0.74	0.26	-6.45	-11.62
1999	9.33	7.68	14.03	9.09	10.32	0.74	0.26	9.41	9.52
2000	12.10	10.26	17.02	33.69	21.35	0.73	0.27	30.41	29.67
2001	11.94	9.79	17.37	-4.60	2.06	0.72	0.28	-2.75	-1.27
2002	12.80	10.25	18.41	4.74	5.99	0.69	0.31	5.11	7.22
1978-2002				-3.61	-3.57	0.80	0.20	-3.60	-2.96
1978-1984				-1.73	-5.55	0.90	0.10	-2.13	-1.93
1984-1991				-8.20	-9.23	0.84	0.16	-8.37	-8.06
1991-2002				-1.61	1.35	0.72	0.28	-0.77	-0.15

Notes: Rate of return (to capital) = (gross profit and tax)/(fixed asset). The fixed asset for non-state owned enterprises (NSE) equals gross fixed asset of the Manufacturing sector minus that of state owned enterprises (SOE), and profit and tax for NSE equals gross profit and tax of the manufacturing sector minus that of SOE. $\hat{r}_M^{UN}$ is the unweighted growth rate of return rate to capital for two kinds of enterprises in Manufacturing sector, SOE and NSE, and $\hat{r}_M$ is the weighted growth rate. Average growth rates for 1978-2002, 1978-1984, 1984-1991, and 1991-2002 shown in the bottom panel in columns (5) , (6) and (10) are compound averages, calculated as using the formula: Growth rate = $(X_t / X_1)^{(1/(t-1))}$ -1,where X_1 and X_t are the values of item for period's first year and last year, respectively, and (t-1) is the length of the period. The average values of S_{SOE} and S_{NSE} for different periods shown in the bottom panel of columns (7) and (8) are arithmetic average of respective yearly values.

Source: NBS (2003) and the authors' calculations.

Table 9: Rate of Return to Capital in the Non-manufacturing Sector and Growth Rate of TFP Estimated by the Primal Approach

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Rate of return to capital		Growth rate (%)					Labor share	TFP growth rate (%)
Year	r_{OC} (Non-manufacturing sector)	r_{OH} (Non-manufacturing sector)	$\hat{r}_{OC}$	$\hat{r}_{OH}$	GDP	Labor	Capital	S_L	$TFPGR_p$
1978	44.09	6.32	—	—	—	—	—	0.50	—
1979	38.48	5.88	-12.73	-7.01	7.60	2.17	7.58	0.51	2.75
1980	38.05	6.33	-1.09	7.79	7.81	3.26	7.19	0.51	2.63
1981	33.24	6.11	-12.65	-3.50	5.26	3.22	6.15	0.53	0.63
1982	30.69	6.20	-7.69	1.45	9.01	3.59	6.66	0.54	3.98
1983	32.17	6.72	4.84	8.36	10.89	2.52	7.26	0.54	6.17
1984	31.30	7.68	-2.71	14.30	15.18	3.79	8.32	0.54	9.28
1985	45.21	8.48	44.44	10.41	13.47	3.48	10.16	0.53	6.87
1986	27.51	9.30	-39.15	9.63	8.86	2.83	9.97	0.53	2.67
1987	25.62	9.96	-6.86	7.13	11.57	2.93	9.58	0.52	5.48
1988	27.84	10.26	8.65	3.07	11.27	2.94	10.05	0.52	4.91
1989	21.72	10.39	-21.99	1.27	4.07	1.83	9.01	0.52	-1.24
1990	15.93	10.33	-26.65	-0.62	3.83	2.55	7.95	0.53	-1.28
1991	15.89	10.88	-0.23	5.34	9.19	1.15	8.09	0.52	4.77
1992	20.08	11.93	26.31	9.61	14.24	1.01	9.30	0.50	9.18
1993	21.76	12.12	8.37	1.59	13.49	0.99	11.53	0.51	7.27
1994	19.91	12.22	-8.47	0.83	12.66	0.97	10.88	0.51	6.83
1995	15.48	12.40	-22.24	1.47	10.51	0.90	10.69	0.53	4.91
1996	13.96	12.33	-9.83	-0.56	9.59	1.30	10.06	0.53	4.18
1997	13.35	12.28	-4.36	-0.42	8.84	1.26	9.38	0.53	3.77
1998	12.71	12.00	-4.79	-2.24	7.82	1.17	8.99	0.53	2.97
1999	14.03	11.59	10.32	-3.46	7.14	1.07	8.64	0.52	2.50
2000	17.02	10.73	21.35	-7.43	8.00	0.97	8.17	0.51	3.56
2001	17.37	10.41	2.06	-2.91	7.50	1.30	8.87	0.51	2.52
2002	18.41	10.12	5.99	-2.84	7.96	0.98	9.44	0.51	2.85
1978-2002			-3.57	1.98	9.37	2.00	8.90	0.52	4.06
1978-1984			-5.55	3.31	9.25	3.09	7.19	0.52	4.20
1984-1991			-9.23	5.11	8.84	2.53	9.26	0.53	3.12
1991-2002			1.35	-0.66	9.77	1.08	9.62	0.52	4.57

Note 1: Rate of return to capital for the Non-manufacturing sector is calculated /estimated using three methods. r_{OH} = (gross profit and tax) / (fixed asset). It is calculated using both CIESY and NIA data. The value of fixed asset for the Non-manufacturing sector equals to gross capital stock minus fixed asset of the Manufacturing sector, while the value of profit and tax for the Non-manufacturing sector equals to gross capital income (data in the column 5 of the Table 7) minus profit and tax of the Manufacturing sector; r_{OC} is looked as equal to r_{NSE} in the column 4 of Table 8; r_{ON}, which is not shown in this Table, is regarded as constant.

Note 2: $TFPGR_p$ is estimated by the primal approach.

Note 3: The average values of labor share for different periods shown in the bottom panel of column (9) are arithmetic averages of respective yearly values.

Source: NBS (2003), SSB (1996–1997), NBS (1999–2003), and the authors' calculations.

Table 10: Growth Rate of TFP Estimated by the Dual Approach

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Capital share by sector		Growth rate (%)				Labor share	TFP growth rate (%)		
Year	S_M	S_O	$\hat{w}$	$\hat{r}_C$	$\hat{r}_H$	$\hat{r}_N$	S_L	$TFPGR_{d,C}$	$TFPGR_{d,H}$	$TFPGR_{d,N}$
1978	0.28	0.72	—	—	—	—	0.50	—	—	—
1979	0.28	0.72	12.64	-9.29	-5.17	-0.12	0.51	1.79	3.83	6.32
1980	0.27	0.73	8.33	-1.44	5.01	-0.64	0.51	3.57	6.71	3.96
1981	0.27	0.73	7.26	-10.98	-4.32	-1.78	0.53	-1.51	1.69	2.91
1982	0.28	0.72	10.28	-6.52	0.10	-0.95	0.54	2.40	5.50	5.01
1983	0.28	0.72	7.98	3.00	5.54	-0.47	0.54	5.67	6.85	4.05
1984	0.27	0.73	9.50	-1.33	10.95	0.62	0.54	4.47	10.17	5.38
1985	0.25	0.75	2.38	34.22	9.15	1.48	0.53	17.27	5.55	1.96
1986	0.26	0.74	1.12	-32.87	3.33	-3.82	0.53	-14.91	2.16	-1.21
1987	0.26	0.74	0.92	-5.53	4.80	-0.47	0.52	-2.15	2.76	0.26
1988	0.25	0.75	-1.49	7.31	3.16	0.86	0.52	2.75	0.75	-0.36
1989	0.24	0.76	-7.24	-20.28	-2.74	-3.70	0.52	-13.55	-5.06	-5.52
1990	0.25	0.75	7.87	-26.49	-6.85	-6.38	0.53	-8.46	0.87	1.10
1991	0.26	0.74	2.33	-1.25	2.91	-1.08	0.52	0.64	2.61	0.72
1992	0.25	0.75	5.44	21.26	8.80	1.62	0.50	13.17	7.08	3.57
1993	0.26	0.74	5.08	7.52	2.46	1.27	0.51	6.29	3.78	3.19
1994	0.25	0.75	6.02	-7.54	-0.58	-1.20	0.51	-0.63	2.78	2.48
1995	0.27	0.73	6.90	-22.80	-5.20	-6.29	0.53	-7.35	1.09	0.57
1996	0.26	0.74	7.81	-10.81	-4.01	-3.59	0.53	-0.92	2.27	2.46
1997	0.28	0.72	3.97	-4.25	-1.37	-1.06	0.53	0.12	1.47	1.61
1998	0.28	0.72	9.58	-5.25	-3.41	-1.80	0.53	2.60	3.47	4.23
1999	0.29	0.71	6.57	10.06	0.24	2.71	0.52	8.22	3.58	4.74
2000	0.29	0.71	5.59	24.02	3.70	8.95	0.51	14.45	4.68	7.20
2001	0.29	0.71	7.34	0.65	-2.86	-0.81	0.51	4.09	2.39	3.38
2002	0.29	0.71	9.50	5.74	-0.51	1.50	0.51	7.66	4.61	5.60
1978-2002	0.27	0.73	5.22	-3.58	0.48	-0.97	0.52	1.01	2.95	2.26
1978-1984	0.28	0.72	9.32	-4.60	1.80	-0.59	0.52	2.67	5.73	4.59
1984-1991	0.26	0.74	0.78	-9.01	1.66	-2.14	0.53	-3.87	1.20	-0.61
1991-2002	0.27	0.73	6.39	0.77	-0.69	-0.21	0.52	3.68	2.98	3.21

Note 1: The values of $\hat{w}$ are from Table 5. The values of $\hat{r}$ in columns (5), (6), and (7) are the weighted growth rate of return rate to capital for the economy comprising of both the Manufacturing and the Non- manufacturing sector, which are calculated from three methods.

Note 2: Average growth rates for 1978-2002, 1978-1984, 1984-1991, and 1991-2002 shown in the bottom panel in columns (4) , (5), (6) and (7)are compound averages, calculated as using the formula: Growth rate = $(X_t / X_1)^{(1/(t-1))}$ -1, where, X_1 and X_t are the values of item for period's first year and last year, respectively, while (t-1) is the length of the period. The average values of S_{SOE} , S_{NSE} and S_L for different periods shown in the bottom panel of columns (2), (3), and (8) are arithmetic average of respective yearly values.

Note 3: $TFPGR_{d,C}$, $TFP_{d,H}$, $TFPGR_{d,N}$ which are calculated by the dual approach, are based on weighted wage growth rate in column (4) and weighted growth rate of capital return rate in columns (5), (6), and (7), respectively.

Source: Authors' calculations.